3.0 Recommendations

Framework for Recommendations

The charge to ReMAP by the NASA Administrator, echoed by the OBPR Associate Administrator, was that ReMAP should concentrate efforts on prioritizing the existing research programs within OBPR. (Also refer to Appendix A, Terms of Reference, 1st paragraph.) In order to do this, ReMAP considered as fully as possible the extensive background of reviews and reports to NASA addressing space research priorities.

- ReMAP performed its prioritization analysis without regard to budget or facility constraints, and recommends the resulting set of priorities for OBPR research to NASA to inform current and future implementation decisions and guide future program development.
- ReMAP was informed of the extent to which NASA can address these research priorities, given the current budget, and current and planned ISS facilities and capabilities. This information did not affect the priorities identified.

3.1 Science on ISS

If enhancements to ISS beyond "US Core Complete" are not *anticipated*, NASA should cease to characterize the ISS as a science driven program.

Rationale:

- OBPR's implementation analysis suggested difficulties in implementing the high priority research given the current and near-term plan.
  - Crew time, resupply upmass, and facilities are major factors.
- Other reasons for ISS include engineering achievement, space commercialization, international leadership, and classroom education.

3.2 ISS Research Productivity

NASA must resolve the upmass and crew research time issue.

Rationale:

- Crew time and upmass were identified as presenting significant restrictions on research productivity under both US and US + IP Core Complete configurations.
- IP barter agreements are based on research that requires greater than a 3-person crew.
- ReMAP understands that NASA is examining crew time availability for research and encourages vigorous attention to this critical resource.

3.3 Current ISS Productivity

As ISS nears completion, NASA should increase science priority and productivity on ISS.

- For each ISS increment, designate one crewmember as the "science officer."
  - The science officer will be the primary crew person to participate in payload training.
  - At least 1/3rd available crew time (assumes a three person crew) should be dedicated to science operations.
  - Other crewmembers also participate in science operations.
- Upmass allocations must support the ISS crew conducting scientific investigations.
  - If this cannot be accommodated on assembly or logistic flights, add a Shuttle flight to the manifest that will bring only science payloads to ISS.

Rationale:

- Currently, science is not a priority for the limited crew time and upmass available for ISS.

3.4 Basic Research

OBPR should include, in its high-priority research portfolio, outstanding basic scientific research programs that address important questions in the physical and biological sciences, and which require long-term experiments on the ISS, based on their intrinsic scientific value.

Rationale:

- OBPR's research portfolio must be built around the most important scientific problems relevant to the NASA mission on the ISS, rather than covering representative sub-fields of science.

3.5 Implementation of ISS Research Facilities

NASA should ensure appropriate funding for implementation of high priority facilities, such as the habitats and centrifuge.

Rationale:

- A number of facilities required to perform the highest priority biological and physical sciences research are currently un-funded or delayed.
- Essential understanding of the full range of effects of gravity on life will require:
  - Appropriate plant & animal habitats
    - Either as previously planned or acceptable alternatives
    - Essential to perform the research
  - Centrifuge capability needed to
    - Identify threshold loading conditions
    - Validate preliminary findings suggesting a role of microgravity where controls (assessment of other factors related to ISS conditions) could not be analyzed.

3.6 Fully Utilize Available Options for Space Research

NASA should consider additional Shuttle science/commercial flight opportunities.

- Investigate dedicated science and/or commercial flights on a regular basis.
  - Guarantee flight opportunities
  - Guarantee routine, repetitive access to space
- Investigate the possibility of auctioning rack space to gauge true market interest.

Rationale:

- Many science priorities do not need long duration in space.
- Many science priorities do need repetitive, routine access to space.
- NASA funding may impact market interest.
- Use of non-NASA funds to purchase a flight opportunity can be used as another indication of the value of the proposed space research.

3.7 Time to Orbit

NASA must reduce the time between experiment selection and flight for research investigations.

Rationale:

- Current long lead-time discourages excellent researchers from proposing to NASA's programs.
- "Time to orbit" is a major commercial partner concern.
- Reasonably short times are essential if graduate students are to be involved.

3.8 Research Funding

In order to attract high caliber scientists from a large national pool, NASA must assure science as a priority commitment with regard to flight schedule and project funding.

Rationale:

- Research funds have been diverted a total of 4 times to cover engineering overruns.
- Office of Space Flight indicated total research slippage for investigators has been as much as 4-5 years.

3.9 Methods for Research Solicitation

OBPR should consider alternative methods for research solicitation and recruiting of key performers.

Rationale:

- Solutions for OBPR's goal-oriented, need-driven research problems may be facilitated by alternative methods of solicitation and recruiting.
  - Project selection by peer review
    - A consensus based approach
    - Works best for individual PI science programs
    - Works best for broad focus, science community driven

- DARPA-style program management
  - Can open new areas
  - Serves to build communities
  - Can support multi-investigator projects
  - Works best for goal-oriented research

3.10 Increase Cadre of OBPR Investigators

OBPR must develop mechanisms to increase the quality and cadre of scientists participating in its research programs.

Rationale:

- More young and active investigators from top research institutions should be recruited to work on NASA's high priority questions.
- The Task Force felt the investigator community should be larger and more diverse.

3.11 Science Leadership

OBPR scientists should ensure the development of a visionary strategic research program that is focused on the problems whose solutions will further the NASA mission.

Rationale:

- Development of a strategic, goal-oriented program will enable selection of the best research to facilitate space exploration and fundamental science.

3.12 OBPR Organization and Process

OBPR should consider interdisciplinary organization and program structures aligned along research questions rather than discipline.

Rationale:

- OBPR is currently organized by discipline.
  - Tends to solicit by discipline, generally single investigator research proposals.
- Alternative organization could be more flexible.
- Many of the high priority questions are interdisciplinary in nature.
  - OBPR programs would be more productive if microgravity physics and life science programs were integrated.
- Different kinds of research require different structures (e.g., team approach vs. single investigator).

3.13 Coordinating Research Efforts

OBPR life sciences strategy should integrate multiple levels of analysis, (i.e., organismal, systemic, cellular, molecular).

OBPR physical sciences strategy should coordinate the research efforts from Fundamental Microgravity, Engineering, Commercial Engineering, and Technology Development where it makes sense. Examples: combustion and fire safety.

Rationale:

- Coordinated strategies focused on specific problems would optimize research productivity.

3.14 Potential New Lines of Research

OBPR should examine potential lines of research outside of the current research portfolio.

Rationale:

- ReMAP Task Force prioritized only the current research portfolio.

3.15 Metrics

Given that NASA has multiple requirements for producing and reporting productivity metrics, the purpose of each metric should be clearly delineated such as science productivity, education outreach, and public affairs.

Rationale:

- Specific metrics, even when accurate, do not necessarily index the measure of interest. For example, media attention is not suitable for evaluation of scientific quality.

3.16 Coordination with International Partners

NASA should continue coordination of facilities development and research solicitations with the International Partners (IP), and attempt to address the IP concerns.

Rationale:

- The IPs have chosen to build certain ISS research facilities and not others to avoid replication based on understanding of shared facility utilization.
- IPs have continued interest in coordination with NASA and submitted analyses of their priorities and concerns to ReMAP.